

*A Proposal for a series of Systematic Surveys of the Star-Depths.* By R. A. Proctor, B.A. (Cambridge).

When we consider the vast addition to our knowledge, and the yet vaster widening of our conceptions respecting the star-depths, which resulted from the labours of Sir William Herschel and the great man whose death science is now deploring, we cannot doubt that more complete surveys, if such could be carried out, would well repay the pains bestowed upon them. I apprehend that not the least among the purposes which the elder Herschel proposed to fulfil when he commenced that first great survey was to show astronomers how much the survey of the heavens was needed; and I imagine that he would have been the last to approve of that supineness (arising, perhaps, from an exaggerated respect for his labours) which has prevented all save his son from pursuing the path which he was the first to indicate. As to the opinion of Sir John Herschel on this matter, it is unnecessary that I should speak; because he has in many parts of his works urged in his own earnest manner how desirable it is that the celestial depths should be studied much more closely than they could be by only two observers, however skilful and energetic, or however patiently they continued their labours for many successive years.

I believe that what is now specially required is a series of systematic surveys, proceeding on a principle quite different from that on which the Herschels found it necessary to pursue *their* researches. A first survey was very properly, or rather, it was necessarily applied with reference rather to the average distribution of the stars than to the special laws of distribution which may be found to prevail either when we extend our survey over the different parts of the celestial sphere, or when we vary the range of our vision by employing different telescopic powers.

I venture now to impress most earnestly on those who have sufficient leisure and possess the necessary instrumental means for carrying out systematic observation, the extreme importance of surveys of the star-depths on methods devised with reference to both these relations.

Let me briefly indicate what is at present wanted, noting at the same time, that the proposed observations should only be regarded as first steps in a progressive series of researches directed to the solution of the noblest of all the problems astronomers can deal with,—the determination of the laws (so far as they are discoverable) according to which the heavens are constituted.

(1.) I have already mapped down isographically the stars visible to the unaided eye; and I think that no one can study my isographic chart, or the numerical statistics which accompany it in the second edition of my *Other Worlds*, without feeling that

even what the heavens disclose to the unaided eye has a significance which has too long been suffered to escape recognition.

(2.) I am engaged in mapping down isographically the stars in Argelander's charts of the northern heavens — 324,000 stars in all, about 310,000 north of the equator, and about 14,000 within two degrees south of the equator. When this chart is completed, it will serve to show, so far as the northern heavens are concerned, what are the laws of distribution among those stars which lie within the range of a telescope  $2\frac{1}{4}$ -inches in aperture. The correspondence between these laws in certain parts (at least) of the heavens, with those observed in the distribution of naked-eye stars on the one hand, or of the Milky Way, nebulae, &c., on the other, will throw light on many questions of interest,—for instance, on the numerical relations of large and small stars (stars really large and small, that is), and (consequently) on the evidence as to the distances of stars of different apparent orders. Light will also be thrown on many other questions of importance. That this is so I shall be able (I already know from the progress of the work) to establish; but at present it will suffice to notice, as evidence of the importance of such researches, that Struve, taking only a small portion of Argelander's charts, and dealing with that portion only by averages,\* not only as respects extension in right ascension and declination, but also as respects probable extension in space, was yet led to results of extreme interest if admitted, and highly suggestive even if regarded as still open to question.

The system of charting with reference to an aperture of  $2\frac{1}{4}$ -in. requires extension over the whole southern hemisphere. The results of this extension alone would be (I venture to predict) of the utmost possible interest. For the purpose of increasing our knowledge of the constitution of the star-depths, actual charting would not be needed, but only such a process of statistical enumeration as I propose in the case of larger apertures.

(3.) The Council of this Society have kindly placed at my disposal the Sheepshanks Equatoreal No. 3, having an aperture of  $4\frac{1}{2}$ -in., and I propose to apply this instrument to the enumeration of stars lying within the increased range belonging to its aperture. The plan I propose to follow is to count the number of stars seen in equal fields taken all over each region surveyed, and then to map down the result isographically. It is probable that the very limited amount of leisure time I can devote to such researches may prevent me from surveying more than a small region of the northern heavens. But as my special object is to show what lessons such surveys are calculated to teach, I shall be well satisfied if I can thus, by example more effectively than by precept, engage others who have more leisure and instruments of

\* How rough these were (intentionally, of course) is shown by the fact that the charted results did not even indicate the division of the Milky Way into two parts over a region crossed by Struve's section. "C'est une suite naturelle," says Struve on this point, "de ce que notre recherche du disque ne s'est point faite dans tous les détails, mais *par heures entières* d'ascension droite."

about the size named to extend this survey to much larger regions. If the results are not charted by the observer himself he should keep a gauge-book from which an isographic chart could be formed hereafter.

The southern heavens also should be surveyed with a telescope of about  $4\frac{1}{2}$ -in. in aperture.

(4.) A survey on a similar plan should be carried out over the whole heavens with a telescope 9-in. in aperture.\*

(5.) Star-gauging with powers about equal to those of the telescopes with which the Herschels surveyed the heavens, should be carried out on a much more complete plan than was possible in the case of astronomers engaged like the Herschels on many different branches of research simultaneously. In the present position of sidereal astronomy, more is to be gained by the complete survey even of a small region in this way (followed by careful isographical charting) than by an incomplete survey depending on a law of averages which has been proved *not* to prevail in stellar distribution.

(6.) A good 4-ft. speculum should be applied to the same purpose, even though half-a-dozen generations might have to be occupied in the work.

Feeling absolutely certain of the extreme interest and importance of the results which would follow from such surveys as I have here advocated, I am by no means deterred by the largeness of the labours involved, even in the complete survey of the heavens with small apertures, from urging those who can do so to join actively in a work so valuable. There are so many amateur astronomers who have fine telescopes for which they can find no employment, and so many others who *do* find employment for their telescopes, but after a fashion tending in no sort to advance our knowledge, that the work ought not to languish for want of recruits. And I should imagine that no training, even, would be wanted by a large number of these recruits; because the eagerness with which telescopists are trying to divide difficult double stars, or to see planetary features which their telescopes are just *not* able to show, and so on, seems indicative of an earnest desire to acquire a fitness for useful work. I have named certain apertures which should at once be applied to the survey, but reflectors and refractors of 5, 6, 7, or any number of inches in aperture, could be most usefully employed in sidereal survey.

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\* I speak here with reference to refractors. If reflectors are used in such a survey a careful comparison of their light-gathering power, and that of refractors employed in the same sort of work should be instituted beforehand. If this power were brought to an equality, or nearly so, different parts of the heavens might be simultaneously surveyed by observers using reflectors or refractors.